FLOWING WELL RULES

Rule 121(c)
Prevent unnecessary discharge of water.

Rule 121(3)(a)
Confining layers must be preserved during well construction and any breeches must be sealed.

Rule 138
Flowing wells shall be grouted:

- To protect the artesian aquifer
- Prevent erosion of the overlying geologic materials
- Confine the flow to within the casing.

Rule 138(2)
Discharge control be provided to

- Conserve groundwater.
- Prevent the loss of artesian pressure.

Flow control shall consist of any of the following:

- Valved pipe connections.
- Watertight pump connections.
- Receiving tank.
- Flowing well pitless adapter.
- Packer.
- Other method approved by the health officer.

A flow discharge pipe shall not be directly connected to a sewer or other source of contamination.

DEVIATION TO ALLOW FLOWING WELL DISCHARGE

A flowing well that is constructed after April 21, 1994 (effective date of the well code revision) may be permitted to discharge water, if a deviation is issued by the health officer of a local health department, pursuant to the provisions of R 325.1613(2)(h) of the well code. The DEQ recommends that discharges be throttled back to not more than 10 percent of the unrestricted flow rate, unless a deviation is obtained. Before a deviation can be issued, the well owner or the owner's representative (well driller) must demonstrate any of the following:

1. Control of the flow is not practical - In some rare situations, controlling a flow may not be practical. The degree of difficulty in controlling the flow is increased if site conditions include a high artesian head, a large flow rate, a thin or unstable confining layer, or a shallow depth to the top of the artesian aquifer. This deviation condition also applies to situations where a technically sound but unsuccessful attempt has been made to control the discharge.

2. Control of the flow will likely result in the production of sand or turbidity in the water - While most flowing wells in unconsolidated geologic formations are completed with well screens, there may be cases where the contractor is not able to install one due to

excessive uphole pressure. In such cases, the discharge rate should be reduced to the lowest pumping rate that will not result in sand or turbidity. It should be recognized, however, that barometric pressure changes, which affect aquifer head, can occasionally result in turbidity production, regardless of flow control mechanisms. Turbidity production may also be caused by insufficient well development.

3. The discharge is for a beneficial use – such as:
   A. Maintaining water levels in a pond used for irrigation, fire protection, fish rearing, recreation, wildlife enhancement, or other commercial purpose.

   B. Supplying a continuous flow of water for heating, cooling, industrial processes, irrigation, or power generation.

The *Flowing Artesian Well Discharge Deviation* form (See Appendix) may be used by local health departments for issuing deviations to R 325.1638 of the well code.

Since many flowing wells are located near surface waters, the discharge of water from flowing wells frequently involves disposal into a lake, river, or stream. If the buried discharge line or spillway passes through a wetland, a soil erosion/sedimentation permit may be needed. Contact the local soil erosion/zoning office to find out whether a permit will be needed.

DISCHARGE CONTROL

Proper control of discharge water from flowing wells consists of:

(1) preventing the discharge of water from around the casing by tightly sealing the juncture between the borehole wall and the well casing, and

(2) stopping or reducing the discharge of water from within the well casing.

The discharge of water from flowing wells can be stopped or significantly reduced, in most cases, if proper steps are taken during well construction. If the flow within the permanent casing is not stopped completely, it is recommended that the flow be reduced to approximately 10 percent of the unrestricted flow rate. If it is intended that the well flow more than 10 percent of the unrestricted flow rate, a deviation must be issued pursuant to R 325.1613 of the well code.

More detailed information on flowing wells can be found in the DEQ's Flowing Well Handbook. It contains detailed information on flowing well occurrence, case histories, well construction methods, discharge control, disinfection and plugging of flowing wells. To receive a copy of the handbook, visit the Well Construction Unit website at www.michigan.gov/deq. Click on "water", then "drinking water", then "water well construction".

Flowing Well Discharge Deviation

This is to allow for a deviation of the provisions of R 325.1638 of the Michigan Well Construction and Pump Installation Code (Part 127, 1978 PA 368). This deviation is authorized under R 325.1613.

Well owner _____ Home phone _____

Address _____ Work phone _____

City _____ State _____ Zip code _____

Well site address _____

Well permit application date _____ Well permit number _____

Unrestricted flow rate _____ gpm Proposed discharge rate _____ gpm

Reason(s) for deviation:

☐ Control of flow not practical – Give reason(s) _____

_____

_____

☐ Flow control will result in sand/turbidity production.

☐ Discharge is for beneficial use:

_____ Maintain water level in pond _____ Fire protection

_____ Industrial process _____ Heating/cooling

_____ Irrigation

Other _____

Person requesting deviation _____ Date _____

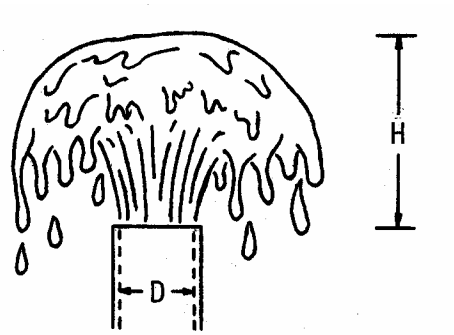
Local health department official _____ Date _____

Local Health Department _____

FLOW RATES

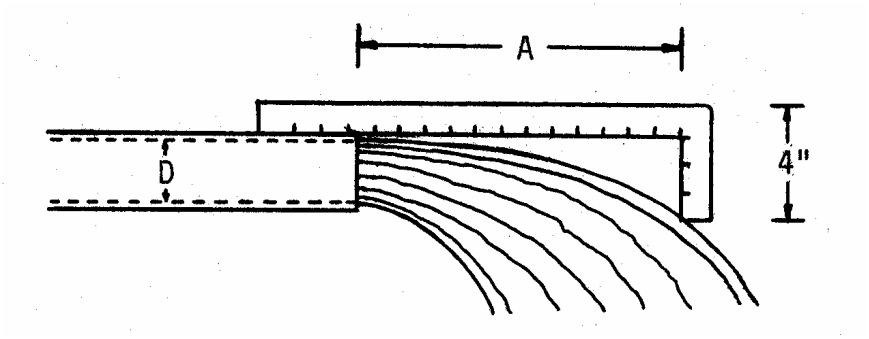
The tables below are useful in estimating flow rates from flowing wells or pump discharges.

VERTICAL PIPE – The approximate flow rate from a vertical pipe can be determined by measuring the height (H) that the water rises above the top of the pipe and the inside diameter (D) of the pipe. Find the flow rates for various H and D values in the table below.



FLOW IN GPM FROM VERTICAL PIPES								
HEIGHT (H) IN INCHES	INSIDE PIPE DIAMETER (D) IN INCHES							
	1¼	2	3	4	5	6	8	10
2	11	28	63	112	175	251	447	698
3	13	35	77	135	217	311	569	950
4	15	41	92	161	252	369	687	1115
6	19	52	115	202	316	469	872	1415
8	22	61	135	236	370	548	1025	1640
10	24	69	153	265	418	621	1155	1840
12	27	76	169	294	463	685	1275	2010
14	29	83	184	319	502	740	1380	2170
16	31	89	197	342	540	796	1480	2320
18	33	95	209	364	575	845	1560	2460

HORIZONTAL PIPE – The approximate flow rate from a horizontal pipe can be determined using an L-shaped measuring square and finding the horizontal distance (A) in inches. This measurement will represent the distance between the end of the pipe and the point that the 4 inch end of the square touches the water. D represents the inside diameter of the pipe. Find the flow rate for various A and D values in the table below.



FLOW IN GPM FROM HORIZONTAL PIPES								
HORIZONTAL DISTANCE (D) IN INCHES	INSIDE PIPE DIAMETER (D) IN INCHES							
	1¼	2	3	4	5	6	8	10
4	10	22	48	83	-	-	-	-
6	15	33	73	125	195	285	-	-
8	20	44	97	166	260	380	665	1060
10	24	55	122	208	326	476	830	1330
12	29	66	146	250	390	570	1000	1600
14	34	77	170	292	456	670	1160	1860
16	39	88	196	334	520	760	1330	2120
18	-	99	220	375	590	860	1500	2390

(From Environmental Health Ready Reference, Michigan Environmental Health Association, 1990)

METHANE/GAS WELL RULES

Rule 156a
Gases shall be vented.

- Vented to the outside atmosphere.
- Consultation for identification and treatment of gases.

Rule 163(4)
Abandoned wells discharging gases shall be plugged with neat cement or concrete.

SAND AND TURBIDITY RULES

Rule 139(1)
Well shall be fitted with a screen that is properly sized to produce sand-free water.

Rule 139(5)
Well shall be developed and pumped to waste until the water is clear.

Rule 121(2)
Well shall be adequate in size, design and development for the intended use.

STATE OF MICHIGAN

JOHN ENGLER, Governor

DEPARTMENT OF ENVIRONMENTAL QUALITY

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RUSSELL J. HARDING, Director

REPLY TO:

DRINKING WATER & RADIOLOGICAL
PROTECTION DIVISION
3423 N MARTIN L KING JR BLVD
PO BOX 30630
LANSING, MI 48909-8130

November 25, 1998

TO: Local Health Departments
Attn: Environmental Health Directors
Supervising Sanitarians
Field Sanitarians

FROM: Michael Gaber, Chief
Well Construction Unit
Drinking Water and Radiological Protection Division

SUBJECT: **Water Wells Producing Sand or Turbidity**

This memorandum provides technical information and guidance on investigating complaints involving sand pumping or other sediment that causes turbidity in well water. Sanitarians will find the information useful for understanding the steps taken or proposed by well drilling contractors to correct such problems.

New wells occasionally pump a small amount of sand or turbidity initially. Once a well is put into routine service the intake area generally stabilizes. Sand grains bridge on the outside of the well screen and sand production ceases. Existing wells can occasionally develop sand/turbidity (ST) problems after several years of service. Over time, corrosion of metallic casing or screens can allow sand or sediment to enter a well. Erosion in the production zone, loss of a drive-shoe seal, and overpumping can cause ST problems. Persistent ST problems can be challenging to correct.

Well Code Requirements

Three regulations contained in Part 127, 1978 PA 368 (Michigan Well Construction Code), pertain to sand production, water clarity, and well development. A new well that produces sand violates R 325.1639(1), which states the following:

> *"A water supply well that is installed in unconsolidated sand and gravel aquifers shall ordinarily be fitted with a screen that has openings which are properly sized so that the aquifer can be properly developed to produce sand-free water at the pumping rate of the permanent pump."*

Another applicable regulation is R 325.1639(5), which states the following:

> *"A new, repaired, or reconditioned well shall be developed and pumped to waste at a pumping rate which equals or exceeds that of the permanent pump, until the water is as clear as is reasonably possible considering the groundwater conditions in the area. The permanent pump shall not be used to develop the well without the owner's consent."*

R 325.1621(2) also applies to ST producing wells. It states:

> *"A well shall be adequate in size, design, and development for the intended use giving due consideration to local groundwater conditions."*

Water well drilling contractors (and property owners who install their own wells) are responsible for complying with these regulations.

Problems Associated with ST Production

1. While ingestion of small amounts of sand or sediment from a water well is not a health concern, their presence can be aggravating and troublesome.
2. Excessive sand and other sediment can damage and decrease service life of the following:
   - pump impellers or bearings, which can decrease pump efficiency
   - pressure tanks
   - valves
   - geothermal heat pumps
   - water treatment devices
   - water heaters
   - aerators
   - plumbing fixtures
   - dishwashers, clothes washers, and dryers
   - clothing and linens
   - finishes of appliances, automobiles, countertops, sinks, utensils, showers, and glass.
3. Severe ST problems can cause reduction of septic system capacity, and plugging of lawn irrigation systems, showerheads, water softener resin tanks, and water lines.

Complaint Evaluation and Problem Diagnosis

Investigation of an ST complaint should involve the following steps:

- Confirm the problem – Visit the site to check the severity of the problem and determine the nature and source of the particulate matter. Is it sand, silt, clay, scale, drilling fluid, or something else that needs to be identified in a laboratory? Sand has a distinctive, hard, gritty texture, while silt feels slippery and claylike. Precipitated iron scale can also cause turbidity. This reddish/brown/orange scale usually rubs away between the fingers, leaving a colored residue. A black scale that leaves a residue with a rotten egg or sewage odor when smeared between the fingers, may be attributed to sulfate-reducing bacteria. Sometimes turbidity is the result of biofilm formation due to microbial growth in the well. Turbidity can also be due to residual bentonite drilling fluid used in rotary drilling operations or bentonite grout that may have infiltrated the filter-pack or native permeable formation surrounding the well screen.

- Review well construction details on the well record. Compare the depth and geologic formation sequence of the problem well to other wells in the vicinity. Surrounding wells that produce clear water may have been completed in a different aquifer or at a different zone within the same aquifer.
- If a replacement well was drilled, ask the owner about the old well. Was it replaced because it produced sand? Is the replacement well free of sand and is the observed sand residual from the distribution system? If so, correction will involve thorough flushing of the plumbing system.

- Determine when the problem began and how often it occurs – Some questions to ask the well owner are:
  1. Was ST present as soon as the well was placed into service?
  2. If ST started after the well was placed into service, how long afterward did it appear?
  3. Was the casing hit by a vehicle or did a lightning strike occur just before the ST started? If so, the casing could have been damaged, allowing sand to enter.
  4. Is ST production continuous or sporadic?
  5. Does the ST problem clear up with extended pumping or does it worsen?
  6. Were there any major increases in water demand (e.g., installation of a lawn irrigation system, pump replaced with higher capacity pump, etc.)? Increased pump capacity will increase water entrance velocity into the well, enabling the water to carry sand into the well.
  7. Does the problem exist at particular faucets, out buildings, or individual pipelines?

- Collect a sample of sand or sediment – Run water into a clean, white 5 gallon pail from the sample tap or outside faucet that bypasses the water softener. To determine the problem's source, it is best to isolate the well from the pressure tank and piping. Before collecting a well sample for sand verification, be sure that the pump is running. This will ensure that the sample represents new water and not water stored in the well. Distribution system samples can be obtained from toilet tanks (if no filter is present) or from filter housing, if a sediment filter is present. Allow sand to settle.

- Inspect sand and compare grain size to well screen slot size shown on well record. This will help diagnose the source of the sand. For example, if the well record shows a 20 slot (0.020 inch opening) and the sand sample is about 0.010," the contractor may have selected an improper well screen. Portable sieves and gauges can be used to identify particle sizes.

- If the screen slot is smaller than the sand sample (e.g., screen slot is 0.010 inches and the sand is in the 0.020 – 0.030" range), improper well screen selection is not the problem. The following causes are possible: (1) the screen may have been damaged during installation, (2) the casing may have been damaged, or (3) the K-packer between the screen and casing may be faulty.

- In filter-packed wells, sand problems may result from improper filter-pack sand selection, bridging of filter-pack above screen, nonuniform or incomplete placement of filter-pack, noncentered screen, or insufficient development.

Common Correction Methods

No single approach will solve all ST problems. Some are easily cured while others can be stubborn. It is important to determine whether the ST problem is an isolated case or if it is surrounded by other wells with the same problem. Most often, an ST problem is an isolated case and can be corrected.

An important factor to consider is the type of well development method and extent of development used by the well driller. Premature termination of the well development stage by the contractor, is a common cause of sand/turbidity problems in new wells. Further development or using alternate development methods may resolve the problem. Ask the driller to explain how the well was developed and the proposed corrective action. One of the following methods may be applicable:

1. Replace the well screen with one having smaller slot openings.
2. Use a portable air compressor or drilling rig compressor to redevelop the screen until the well is sand-free at a pumping rate at least twice that of the permanent pump. A well will generally remain sand free if the permanent pumping rate is lower than the discharge rate used during final development.

3. Switch to a different development method than that used initially. For example, if the well was developed with air, redevelopment with a plunger may be successful. Another technique is to water jet within the well screen. A high pressure, high velocity water stream is injected through a pipe placed within the screen. Jets or nozzles near the end of the pipe, or on a special jetting tool, force water horizontally through the screen openings. Sand-laden water is then air lifted out of the well.
4. Resetting the screen at a different elevation may solve the problem. Sometimes, deepening the well a few feet will move the screen into a zone with different sand gradation.
5. If redevelopment is unsuccessful, or if screen replacement is not possible, replacement of the well with a filter-packed well (also known as "gravel-packed") may be necessary. This involves placing specially selected filter sand outside the well screen. Filter-packing technology has reduced sand production problems throughout Michigan.
6. Reduction of the pumping rate may alleviate ST production. Decreasing the pumping rate lowers the water entrance velocity. Therefore, the energy of the water to carry suspended solids is reduced. Installation of a flow-restricting valve on the pump drop pipe may provide relief.
7. The installation of an additional well screen (if sufficient formation is present) is a common correction method. The added intake area lowers the water entrance velocity.
8. While performing corrections to remedy an ST problem, the well depth should be checked and compared to the depth reported on the well record. Sediment that has accumulated in the bottom of the borehole should be flushed out.
9. ST problems in existing wells can result from mineral incrustation or biolfilm formation. Partial screen plugging increases water entrance velocity and energy. The faster-moving water is able to carry particulate matter more readily. Rehabilitation of a well to restore well yield can correct an ST problem.

Other Causes

Some additional causes of ST problems are:

- An unsealed annular space - sediment can move downward from the annulus into the well intake during pumping. A complaint that a well becomes cloudy after a rainfall, or subsidence around the casing, are likely signs of an ungrouted annulus.
- Placement of bentonite grout adjacent to the well screen.
- A failing check valve above a submersible pump can also cause an ST problem because of the surging action of water exiting the drop pipe.
- In bedrock wells, sand or turbidity may be the result of inadequate sealing between the casing and the bedrock or leakage around the drive shoe. Sediment can enter from a sand-bearing formation above the bedrock. Sometimes, reseating the drive-shoe will resolve the problem.
- Sloughing shale formations or friable sandstone zones can cause ST problems. Correction can often be achieved by installing a liner with packers to isolate the problem strata.
- Some flowing wells may produce slight turbidity when the flow is restricted or upon severe changes in barometric pressure.

Filters and Separators

If the ST problem is present because of geological limitations and the well has been properly designed, correction options may be limited. Sediment filters and sand separators do not correct the source of the problem, but can be effective at preventing particles from reaching the water distribution system. Their use should be considered only if the ST problem is geologically controlled. Devices such as filters or separators should be used only as a last resort and not as a substitute for proper well design or

development. Always try to address sand/turbidity problems at their source.

Clean-up of Water System

After the source of the ST problem has been corrected, sediment should be flushed from the water distribution system. Failure to do so will result in residual sand or sediment continuing to show up at sinks, showers, and toilets. To the well owner, it will appear as though the problem has not been corrected.

Once clear water is being produced from the well, all distribution system piping should be flushed. Hook a garden hose to a tap at the end of the building opposite from the pressure tank. Do not discharge the hose into the septic system. Turn on the tap and flush at full force. Gently tap exposed plumbing lines to loosen sediment. Remove and clean showerheads and aerator screens from faucets. Drain water heater and pressure tank (several flushings may be needed). Be sure to turn off poser to hot water tank before draining. Clean any sand filters and filter housings that may be present. Contact a water treatment dealer to flush sediment that has accumulated in the water softener resin tank. Injecting compressed air into pipelines also helps eliminate sand or other sediment.

For Further Information or Technical Assistance

Contact the Michigan Department of Environmental Quality, Well Construction Unit, at phone 517-335-9183 or fax 517-335-9434 or the Upper Peninsula Office at phone 906-784-6410 or fax 906 786-0624.

MSG:ckh